# Pest Management Grants Final Report
# Agreement No. 00-0198S

**Contract Title:** *Areawide Implementation of Mating Disruption in Pears Using Puffers*

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*Prepared for*

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## EXECUTIVE SUMMARY

Codling moth (*Cydia pomonella*) (CM) is the primary insect pest of pears in California. The maximum threshold for cannery damage is 5% (including all other defects). Food Quality Protection Act (FQPA) and CalDPR use restrictions on azinphosmethyl (e.g. Guthion®) and encapsulated methyl parathion (i.e. Penncap®) have necessitated the rapid transition to alternative CM control programs, mainly using mating disruption (MD). Resistance of CM to azinphosmethyl is another factor stimulating decreased dependence on that material.

CM MD has been studied in California since 1986. The main commercial strategy employed in California has been to hang 160-400 individual codlemone dispensers per acre twice during the growing season. This is a labor-intensive process during an era of tightening labor availability, increasing costs, and relatively decreasing returns. In addition, users in some locations have also experienced variable pheromone emission during very cool or hot weather, which has led to diminished disruption in some cases. The late Dr. Harry Shorey of UC Riverside developed a new emission strategy to resolve the above issues. His dispenser was designed to emit a very large, uniform amount of pheromone at preset intervals, thus eliminating emission variability. Only one hanging of one or two units per acre was necessary, greatly reducing labor cost. Dr. Shorey named the unit the "puffer", and upon his death in 1998, it was developed commercially by Paramount Farming Co. of Bakersfield, California, and was named the Paramount Aerosol Pheromone Dispenser® in 2000. In late 2001, the owner of Paramount, Roll International, purchased another maker of pheromone dispensers, Concep, Inc., and renamed the company Suterra. The puffer is now being sold as the Suterra CM Puffer.

MD research using puffers on the North Coast began in 1996 in cooperation with Dr. Shorey. Initial trials, sponsored by the Pear Pest Management Research Fund, took place on 160 acres of Bartlett pears in Kelseyville, Lake County. In 1999, acreage expanded to 500 with funding from the USDA Codling Moth Areawide Management Program (CAMP), and to 820 in 2000 under a CalDPR Demonstration Grant and the Pear Pest Management Alliance. (360 acres of pears in Potter Valley, Mendocino County, virtually the entire acreage in the valley, were also treated in 1999, the first year of CalDPR Demonstration Grant funding). Participants in 2000 included ten growers and five licensed pest control advisers (PCAs). The project was successful and expanded again in 2001 to 1300 acres managed by 14 growers and five PCA's. Standard treated orchards in the area had historically high CM pressure, requiring from three to four organophosphate treatments most years. In 2001, dispensers were hung at a rate of 1.13 per acre, the same as in 2000, but down from 1.3 in 1999 and 1.6 in 1996-1998. 42 mg. of codlemone was emitted every 15 minutes from 3:00 p.m. to 3:00 a.m. from April 1 through early October.

From 1996-2000, CM adult activity was monitored by UC Cooperative Extension (UCCE) staff using four traps per five acres: 1 mg. low, 1 mg. high, 10 mg. high, and oblique-banded leafroller (OBLR) (the major secondary pest of CM MD programs). In 2001, transition began from UCCE-management to PCA/grower management and UCCE only monitored traps in 51% of project orchards. Of these, the original five received the historical trapping rate, while fewer traps were used in the rest due to resource limitations and the desire to discern if the trapping rate could be lowered without incurring undue risk. PCA's in turn increased their level of trapping to ensure adequate coverage in all blocks.

Egg laying and larval infestation was evaluated in 2001 as in preceding years for each CM and OBLR generation using tree, ground, and bin samples during both the growing season and after

harvest. Puffer-treated orchards were compared to four upwind sites: two 10-20-acre standard-treated blocks, and two sets of untreated trees. Although supplemental treatment decisions were made by growers and PCAs, all first year growers and those that had CM damage in 2000 were advised to apply an initial organophosphate (OP) and/or border sprays as needed.

Samples taken prior to, during, and after harvest showed virtually no CM damage in most puffer blocks, despite the fact that no OP's were applied during the growing season to orchards that had been in the program more than two years. Damage in the 58 puffer blocks was 0.10% at harvest and was restricted to mainly second year blocks with carryover from 2000 (several of which had begun trainsitioning to organic in 2000), and border blocks adjacent to less effective MD methods and large open spaces. Damage in the standard grower control was 0.3%. Damage in untreated controls was 62%, 27% higher than in 2000. OBLR damage averaged 0.5% and was present at very low levels in nearly all blocks at harvest, but exceeded 1.0% mainly in those blocks lacking pre-bloom chlorpyrifros (Lorsban®) applications.

Total material and monitoring costs using puffers was tabulated in 1999 and is being updated for 1st, 2nd, and 5th year orchards using 2002 costs. For an individual orchard of 40 acres or less, material costs using two dispensers per acre are $240/acre initially, plus $350 for a programming unit and negligible labor costs. This decreases to $160/acre thereafter. The number of units per acre decreases as treated acreage increases, offering substantial savings when applied on an areawide basis. CM MD is currently more expensive to monitor than a standard organophosphate program. Much of the additional monitoring costs have been underwritten by various grant funds, but will be borne completely by growers in 2002. PCA fees will average about $50 per acre versus $35 for a standard insecticide-treated orchard. The less intensive trapping rate utilized in 2001 was an attempt to decrease monitoring costs as growers began the transition to private sector management and as confidence in the MD technique increased. Monthly pesticide use report data was collated from 1998-2001 to determine if reduced pear psylla and spider mite treatments after the first year offset the added material and monitoring costs. For example, the only blocks which required a post-harvest mite and/or psylla treatment in 2001 were those which received in-season OP sprays. Sixth year puffer orchards received one or no in-season mite or psylla sprays.

Progress and results of the 2001 Kelseyville project season and for 1996-2001were presented at English and Spanish at summer field days in Lake and Mendocino Counties and at the North Coast Pear Research meeting in Ukiah (see 2001 Progress Report). Although grant funding ended after the 2001 season, two new growers farming approximately 100 acres will join the Kelseyville areawide group and all current members will again use puffers. The group met in March 2002 to discuss potential coordination and will meet again in the spring. One main concern is whether puffers will be allowable under the new federal organic rules, as 4-5 project orchards began transitioning to organic in 2000 and 2001.

Results from the 1999-2001 USDA/CalDPR project have led to increased puffer use in other areas of Lake County and in Mendocino County, as well as renewed interest in the technique in walnuts and pears in other areas of California. Total puffer treated acreage is now about 2500 on the North Coast, or about 30% of the acreage.

## INTRODUCTION

Codling moth (*Cydia pomonella*) is the key pest of pears in California. The economic threshold for damage in cannery loads is 5% (including all other defects). Damage in untreated controls ranges from 10 to 50%, signifying great need for effective control. State and federal actions in 1998 and 1999 have resulted in the restriction or loss of the two key organophosphate insecticides used to control codling moth, azinphosmethyl (e.g. Guthion®) and encapsulated methyl parathion (e.g. Penncap®). These restrictions have necessitated rapid transition of the pear industry into alternative pest management programs. The most proven and available current alternative is mating disruption, which has been researched in pears since 1987. Mating disruption has been demonstrated to be most effective when utilized on an areawide basis in orchards under low to moderate codling moth pressure. The most widely used strategy is hanging 150-400 pheromone dispensers per acre throughout a treated block. Each dispenser emits a small amount of pheromone over the life of the unit, about 60-120 days.

The demonstration project carried out from 1999-2001utilized an alternative, reasonably priced dispenser, the "puffer", developed by the late Dr. Harry Shorey of UC Riverside. The puffer has been further developed and registered by Paramount Farming Co., a large almond and pistachio operation in Bakersfield. It is manufactured in Canada and was sold directly by the new subsidiary Paramount Ag Technologies, Inc. through 2001. The codling moth product is now called the Suterra CM Puffer®. Suterra is the company formed from the sale of Concep, Inc. to Roll International, owner of Paramount Ag Technologies, in late 2001. Rather than hanging many dispensers that each emit small amounts of pheromone, this method involves hanging two or fewer dispensers per acre, each emitting a large amount of pheromone at preset intervals and above a minimum ambient temperature threshold for 200 days. This dispenser was the focus of three years of pear industry-funded UC research on 160 acres in Lake County, which expanded to 500 acres in 1999 under a USDA Codling Moth Areawide Project (CAMP) grant then 820 acres in 2000 under the current sponsorship of California Department of Pesticide Regulation (CalDPR) through the Pest Management Demonstration Grant and Pear Pest Management Alliance programs. The project expanded to 1,300 acres managed by 14 growers and 5 PCA's in 2001 (Figure 1).

The success of the Lake County project led to an additional areawide puffer project in 1999 to control codling moth on 360 acres of Bartlett and Bosc pears in Potter Valley, Mendocino County under the sponsorship of a CalDPR Pest Management Demonstration Grant. This was nearly the total acreage in the valley and included 75 acres of certified organic fruit. Only one 22-acre block of Bartletts and one 2-acre block of organic pears remained untreated which were used as "grower controls". One set of untreated apple trees upwind of the project area served as a completely untreated control. Results were excellent in non-organic blocks, which received no OP treatments for the entire season. The organic blocks remained problematic due to extreme initial pressure and inability to adequately supplement MD due to the incompatibility of oil used for CM with sulfur used to control pear scab in the spring. Due to very poor market conditions, however, the Potter Valley project was disbanded in 2000 as the growers could not commit to purchasing puffer units.

The expanded Lake County project, however, continued to demonstrate the four primary objectives through 2001:

1) Demonstrate a cost-effective, labor saving, efficient, commercially available method of delivering pheromone in a mating disruption program.
2) Verify the minimum level of monitoring needed to commercially use this method.
3) Produce commercial yields of U.S. #1 Bartlett and Bosc pears using greatly reduced amounts of organophosphate insecticides.
4) Control secondary pests as needed.

**RESULTS**

a) ***Objective 1:*** *Demonstrate a cost-effective, labor saving, efficient, commercially-available method of delivering pheromone in a mating disruption program.* Damage patterns in 2001 resembled those in 2000. CM damage to puffer-treated blocks at harvest was less than 0.1% overall across 58 blocks versus 0.3% in the standard control blocks and 61% in the untreated controls. Damage occurred primarily in orchards with overwintering CM pressure from 2000, those transitioning to organic, and those with large edge effects i.e. where the orchard bordered less effective mating disruption, or large open areas, or in proximity to piles of removed or under-farmed trees. Versus 2000 when damage was mainly in first year blocks, most damage in 2001 was in second year blocks which were the same ones with problems in 2000. Most first year blocks avoided damage due to 1-3 supplemental treatments of azinphosmethyl (e.g. Guthion®) or tebufenozide (Confirm®). Damage averaged 0.09% in first year blocks (located on the south and west upwind borders), 0.34% in second year, 0.04% in third year, 0.0% in fourth, and 0.02% in the original blocks treated since 1996. The puffer units lasted the entire season, showing only one hanging per season is required, although there was concern about battery life late in the season (Tables 1 to 2 and Figures 2 to 5).

b) ***Objective 2:*** *Verify the minimum level of monitoring needed to commercially use this method.* Of 32 moths caught in UCCE 1 mg. low traps in 2001, 28 were in grower and untreated controls and three of the remaining in orchards that had pressure in 2000. There were several orchards with damage but no catch in 1XL traps and two orchards with 1XL catch but no damage. 1 mg. high traps caught 91 moths, but also caught moths in some blocks that had no 1 mg. low catches. 10 mg. high traps caught the most moths in the puffer blocks (136). Correlation between trap catch and damage was much lower than in 2000. The best correlation with damage in 2001 was with 10 mg. high traps, which correctly predicted damage in 58% of the blocks where it occurred, and likewise correctly predicted no damage would occur in 58% of damage-free blocks. 1xH traps correctly predicted damage would occur only 36% of the time it occurred but was 58% correct in predicting no damage. UCCE-monitored OBLR traps caught many moths, but as has been the case previously, numbers showed little correlation to severity of damage.

c) **Objective 3:** *Produce commercial yields of U.S. #1 Bartlett and Bosc pears using greatly reduced amounts of organophosphate insecticides.* No OP or other CM-target insecticide was applied to most multiple year blocks during the 2001 season, versus the standard block that received at least two sprays. First year blocks with moderate pressure received one to three OP or tebufenozide (Confirm®) treatments depending on trap catches and egg sampling. Organic transition blocks received several applications of oil at egg laying. Exact amounts of insecticides applied from 1998 to 2001 are currently being compiled from monthly use reports.

d) ***Objective 4:*** *Control secondary pests as needed.* No attempt was made to dictate secondary pest control. Leafrollers were generally controlled by one pre-bloom chlorpyrifos (i.e. Lorsban®) and one or more tebufenozide sprays for the first summer hatch. OBLR damage averaged only 0.5% at harvest and ranged from 0.0-2.4%. Damage was worst where no pre-bloom Lorsban® was applied, and near riparian corridors. OBLR trap counts again appear to be uncorrelated with damage. One in-season spray was applied for pear psylla and mite control in most puffer-treated orchards, although some orchards received no treatments for these pests except dormant oil. Post-harvest treatments were unnecessary in most puffer-treated blocks except for sulfur applied for pear rust mite. (Data on secondary pest treatment will be compiled from monthly use reports). Boxelder and stink bug damage was much higher this year and has become the newest secondary pest issue in the program. No San Jose scale was found.

## DISCUSSION

Data at harvest in both 2000 and 2001 indicated several points:

1) Mating disruption, specifically puffers, controls codling moth well even in a first year program *if* orchards start the season with relatively low pressure, and particularly when supplemented by at least one well-timed, effective cover spray. The newly registered insect growth regulator tebufenozide (Confirm®) was used in many orchards this year rather than azinphosmethyl and appears to have given acceptable control where CM pressure was low to moderate.

2) Orchards that begin the season with high pressure will require greater supplementation by insecticides and more years to achieve adequate control. In 2001, the most problematic orchards were those with pressure from the 2000 season, transitioning to organic, or bordering underfarmed orchards or piles of cut trees. Two CM flights occurred during harvest in 2001, a period where flight is often poorly monitored and infestation cannot be controlled. This will further exacerbate pressure next spring (see 2001 Progress Report).

3) Current poor economic conditions in the pear industry have caused a large number of removed and underfarmed orchards. Situations include: 1) some piles of felled trees last year which remained in place through the season; adult CM then emerged and flew to nearby orchards. 2) orchards that were removed but single rows of trees left uncared for around the perimeters, and 3) severely underfarmed orchards which increased pressure on neighboring blocks. These circumstances, combined with favorable conditions for CM development, greatly challenged mating disruption in 2001, and will likely continue to do so in 2002.

4) Leafrollers, specifically oblique-banded leafroller (OBLR), were controlled well with pre-bloom Lorsban® and/or in-season applications of Confirm®. Confirm® often replaced azinphosmethyl for CM control and in many cases there was enough overlap in spray timing to reduce the severity of both CM and OBLR damage. Confirm® also replaced BT as the primary in-season OBLR treatment.

5) The major secondary pests in 2001 were true bugs, particularly boxelder and stink bugs, but also possibly other types. Many field-run cannery loads exceeded 5% total defects due to true bug damage. It remains to be seen whether these pests will be a chronic problem or were simply more abundant due to the dry winter, but are the focus of applied research in 2002.

6) As a mating disruption tool, puffers are good dispensers in that distribution pattern, emission rates and timing are controllable and flexible, and they are only slightly affected by changes in ambient temperature (due to vapor pressure shifts). Experience in 2001 brought out several economic and logistical issues:

    a. In 2001 growers were responsible for deploying, checking and taking down their own units. It was emphasized by UCCE through the season that units must be periodically taken down and checked to make sure they are emitting correctly. They are susceptible to being knocked down by heavy wind and human activity, such as spraying and harvesting. In 2001, batteries appeared to last through the season, although the reading on some units went to zero. Some of the newly-designed closed battery cases were also subject to cracking. Checking each unit takes about one minute per unit and can be done at the same

time traps are checked. Another two or three minutes is required if reprogramming is required.

b. The accompanying programming unit currently costs $350.00 and must be purchased separately by the user(s). In 2001, users largely did their own programming and became trained in its function to avoid possible misprogramming.

c. The current initial cost to enter the puffer program is theoretically an impediment to adoption, especially in poor market years (though growers have thus far been undeterred). For example, at the maximum two per acre for one 40-acre block, the cost would be $40.00 per unit x 2 = $80.00 plus $80.00 per filled cannister x 2 = $160.00, for a total cost of $240.00 per acre. Cost to hang, check and remove adds about $3.00 per acre. This is compared to $220.00 for two hangings of 400 Pacific BioControl Isomate C-Plus dispensers plus about $25.00 per acre per hanging for application, or about $270.00 per acre per season. Once the puffer and programming units are purchased, they are guaranteed for at least five years, so annual cost for a 40-acre or less block is reduced to $160.00 per year plus hanging, checking and removing.

As the number of acres in puffers has increased, the number of units per acre has decreased, making the system most cost effective for areawide programs where growers share up front and ongoing program expenses and benefit from reduced per acre costs. Also, as the total number of units purchased increases, the manufacturer will theoretically be able to purchase pheromone at a cheaper price, thus reducing the cost of a filled cannister. Care must be taken, however, to deploy an adequate number of units to be effective. Failing to do so will result in more in-season insecticide treatments and/or damage at harvest.

In 2001, the 1,300 acre project in Kelseyville remained at 1.13 units per acre; the rate was the same as 2000 because of the large number of orchard removals surrounding the project area, as well as the location of new orchards on the southern upwind side. Given the increased CM pressure in 2001 due to late season flights and continued economic hardship, puffers were added to some orchards during the growing season and others in retrospect probably should have utilized an increased number of units per acre.

7) There appears to have been less correlation between trap catches and damage in 2001 than in previous years. One factor may have been the reduced rate of trapping (1 set per 10-20 acres versus the previous 1 set per 5 acres). A grant was obtained from the pear industry by the P.I. and Dr. Frank Zalom of UC Davis to complete an analysis of trap catches and damage data from 1996-2001 to determine the best correlation of trap rate, type and catch timing with damage. Both UCCE and PCA data will be utilized. Once this is complete, it will be easier to determine the effect of reduced trapping density (Appendix VI).

8) Several PCA's have increased their monitoring fee in mating disruption orchards to about $50 per acre, a $10-20 increase from previous rates. It remains to be seen whether the withdrawal by UCCE from trapping and damage counts will affect program success.

## SUMMARY AND CONCLUSIONS

The UC Shorey "puffer", now sold as the Suterra CM Puffer®, was utilized to control codling moth (CM) in an areawide demonstration project in Kelseyville, Lake County. The project was an expansion of an industry-funded one initiated by Dr. Harry Shorey and the current Principal Investigator in 1996. The original 163 acres are now in their sixth year. An additional 337 acres were added in 1999, which expanded to 820 acres in 2000 and to 1300 acres in 2001.

Acreage added in 2001 was almost all to the south (upwind) and east (downwind). It was expected the southern blocks would require supplemental organophosphate (OP) treatments to reduce the incoming population and mitigate certain "edge effects".

Puffers were hung at an average rate of 1.13 per acre (the same rate as in 2000), mainly around the perimeter of each block. Both codling moth and leafroller populations and damage were monitored throughout the growing season. Trap catch, egg laying, and damage data showed that:

1) Codling moth pressure on the North Coast continued to increase in 2001, with higher overall trap catches and damage in all growing areas. Despite this, damage in the 58 puffer-treated project blocks was only 0.09% versus 0.30% in standard treated blocks and 61% in untreated controls..
2) Virtually all damage occurred in upwind blocks, those transitioning to organic, and those bordered by either a) large open space or vineyard, b) less effective mating disruption programs, or c) in close proximity to under-farmed orchards or piles of felled trees. Damage also occurred in proximity to one of the untreated controls with a high population.
3) Damage was reduced to nearly zero in third year orchards and was virtually zero in fifth and sixth year orchards, despite a complete lack of OP sprays for several years.
4) OBLR damage decreased greatly in 2001 due to widespread adoption of a pre-bloom chlorpyrifos application. Tebufenozide (Confirm®) applied for CM also provided enough overlap to control the first summer generation hatch.
5) The main secondary pests were true bugs, mainly boxelder and stink bug. Pear psylla and spider mite damage was minimal in puffer-treated blocks despite the omission of the pre-harvest treatment required to control mites in standard-treated orchards. Pear rust mite required treatment in some blocks after harvest due to greatly reduced avermectin (i.e. Agrimek®) sprays during the growing season.
6) Trap catch data was less successful in predicting damage in 2001. 1XL catches were minimal except in the untreated controls and two high pressure puffer blocks and failed to predict damage outcome correctly in several cases. A reduced trapping rate may have contributed to the poorer results.

Despite challenges, results after 2001 continue to be encouraging. Despite the ending of the CalDPR grant, there will be two new growers and 60-100 acres added to the areawide project in 2002. As previous research and other demonstration projects have shown, however, mating disruption of any type is a multiple-year, multi-tactic strategy. In the Lake County project, one orchard required three years to reduce damage to zero and it is likely those with damage this year will need to receive at least one OP for the next one or two years. Growers must thus make a long-term commitment to the program, which often includes high initial costs required to reduce flight and subsequent damage. Orchards transitioning to organic will likely have problems due to lack of adequate supplemental materials. Also, the allowability of puffers under the new USDA rules for organic certification is as yet undetermined. Another critical aspect of intensive CM MD is the increased risk of damage due to external sources of CM. A plan to eliminate pressure from adjacent or nearby unfarmed apple and pear trees, especially upwind, will be

necessary as mated females can fly 100 or more yards from an infested tree. Finally, accurate and cost-effective monitoring also continues to challenge the long-term feasibility of MD, especially after the withdrawal of grant funds from the program. PCA fees in the Lake County project have risen 43% since it began due to more complex and risky circumstances. Development and implementation of effective and cost-effective monitoring methods is critical to future success.

The following predictions and recommendations have been made by UCCE to growers and PCA's to facilitate smooth transition to the private sector:

1) WHAT TO EXPECT IN 2002:

- Participants should expect continued increasing codling moth pressure due to non-farmed or under-farmed trees, overwintering pressure from 2001, unburned piles of cut trees, and more open fields and exposed borders.

- There may be fewer chemical options if Guthion® use is restricted to 5 lbs. per season. Imidan® and Confirm® are generally less effective and the effectiveness (as well as disruptiveness to natural enemies) of Danitol®, the newly-registered pyrethroid, is yet to be determined.

- It is important to have a strong, ***early*** CM supplemental control program in orchards with overwintering pressure. It will be very difficult and disruptive to "catch up" later in the season. This is especially the case for organically-farmed blocks.

- It is very important to monitor traps ***and*** eggs ***and*** damage. Ideally, the recommended damage evaluations are: 1st generation tree and ground, 2nd generation tree and bin, and a 2B/3rd generation tree sample ***after*** harvest. At a minimum, the post-harvest tree sample of 300 fruit per block should be taken. This will show whether there will be a problem the following spring. The intensity of egg and damage sampling will ultimately be determined by economics. There will hopefully be more effective trapping systems (e.g. the new USDA DA lure) as well.

2) GUIDELINES FOR TRANSITIONING TO A PUFFER MATING DISRUPTION PROGRAM:

- Plan to begin with 2 units per acre if surrounded by open borders.
- Utilize one or two midlines of puffers to boost pheromone in the centers.
- Place units to the inside of the orchard (1st or 2nd tree).
- Place more units upwind than downwind.
- Place units in the top 1/3 of the canopy.
- Check 20% of units every 2 weeks (or choose an alternate, convenient schedule).
- If the unit appears "dry", take down and check immediately.

It is hoped that the experience and success of the Lake County Areawide Codling Moth Puffer Project from 1996-2001 will be useful to those who wish to employ the strategy.

## APPENDIX I

### List of Figures and Tables

**TABLE 1:** Summary of CM Damage at Harvest – bin, 1996-2001
**TABLE 2:** CM and OBLR Damage – bin, 2001

**FIGURE 1:** Kelseyville Puffer Locations - 2001
**FIGURE 2:** Effect of years in project on total average damage, 1996-2001

**TABLE 3a:** Effect of time in project on CM damage – pre-harvest, 1996-2001
**TABLE 3b:** Effect of time in puffer project on CM damage – bin, 1996-2001
**TABLE 3c:** Effect of time in puffer project on damage – post-harvest, 1996-2001

Table 1: **Summary of Codling Moth Damage at Harvest For Puffer Treated, Grower, and Untreated Control Orchards 1996 to 2001**

| Year | No. Acres | No. Puffers per Acre | Average % Bin Damage | |
|---|---|---|---|---|
| | | | Grower | Untreated |
| 1996-1998 | 163 | 1.6 | 0.6 | 26.4 [1] |
| 1999 | 500 | 1.3 | 0.01 | 25.5 [2] |
| 2000 | 820 | 1.1 | 0.15 | 47.9 [3] |
| 2001 | 1400 | 0.8 – 1.0 | 0.1 | 61.2 [4] |

[1] Average of 2 blocks: Quercus/7 Acres & Y/Stage
[2] Average of 3 blocks: Quercus/7 Acres, Gold Dust & Y/Stage
[3] Average of 2 blocks: Quercus/7 Acres & Gold Dust
[4] Average of 2 blocks: Quercus/7 Acres & Gold Dust

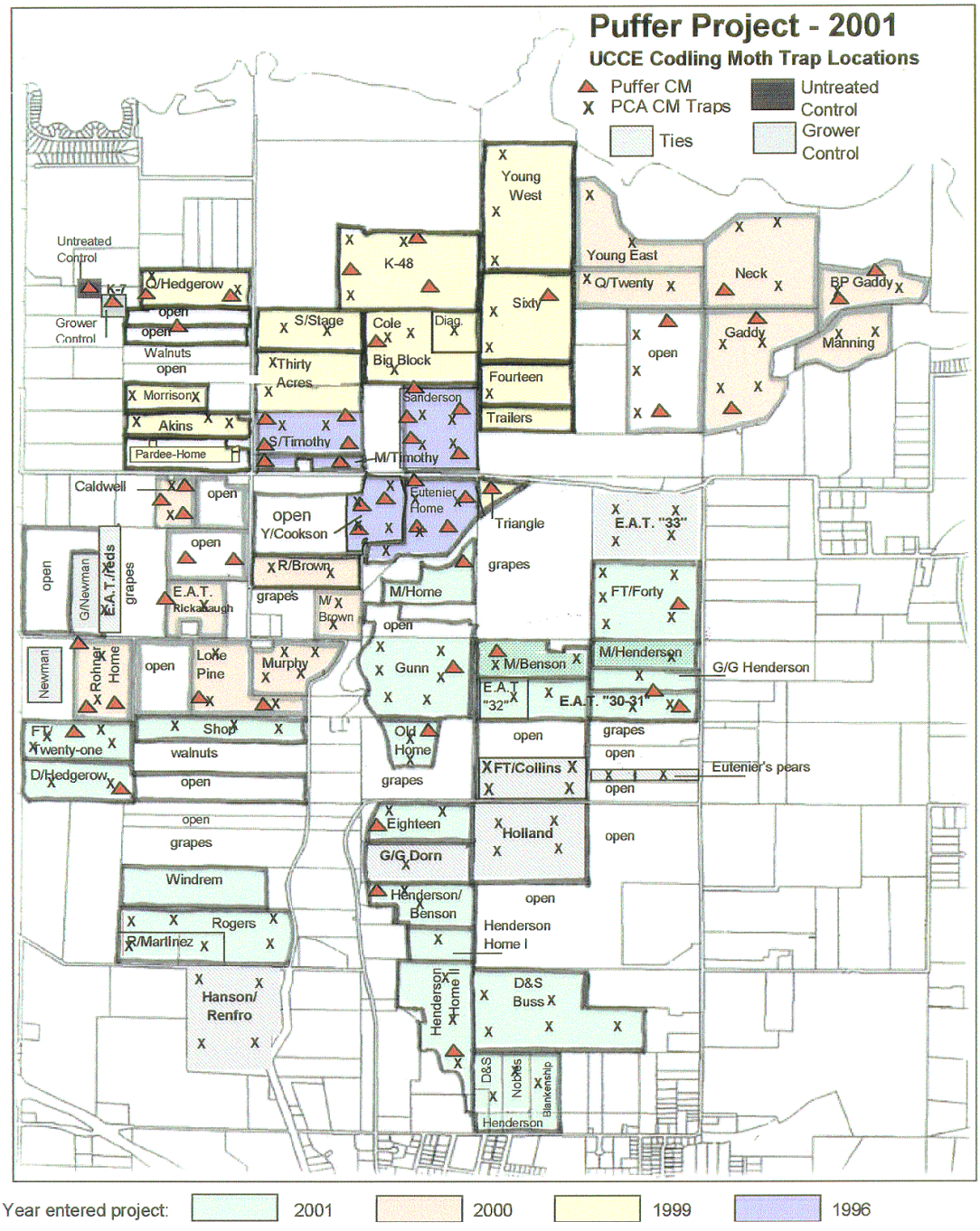
Table 2: **Codling Moth and OBLR Damage August 6-28, 2001 1841-2263 CM °D & 2117-2677 OBLR °D Bin Fruit Samples – Average %/1000**

| Treatment/Project Year | CM | OBLR |
|---|---|---|
| **PUFFER** | | |
| First year | 0.1 | 0.1 |
| Second year | 0.4 | 1.0 |
| Third year | 0.02 | 0.4 |
| Fourth year | 0.0 | 0.2 |
| Sixth year | 0.02 | 0.6 |
| ***Average Puffers*** | ***0.1*** | ***0.5*** |
| **GROWER CONTROL** | | |
| Otto | 0.3 | 0.0 |
| Quercus Seven Acres | 0.4 | 0.8 |
| Newman | 0.2 | 0.5 |
| G/Newman | 0.4 | 0.8 |
| ***Average Grower Control*** | ***0.3*** | ***0.5*** |
| **UNTREATED CONTROL** | | |
| Quercus/Seven Acres | 32.1 | 0.2 |
| Gold Dust * | 90.3 | 1.6 |
| ***Average Untreated Controls*** | ***61.2*** | ***0.9*** |

* Not a bin count

**Figure 1**

**Prevailing winds: N, NW, S**



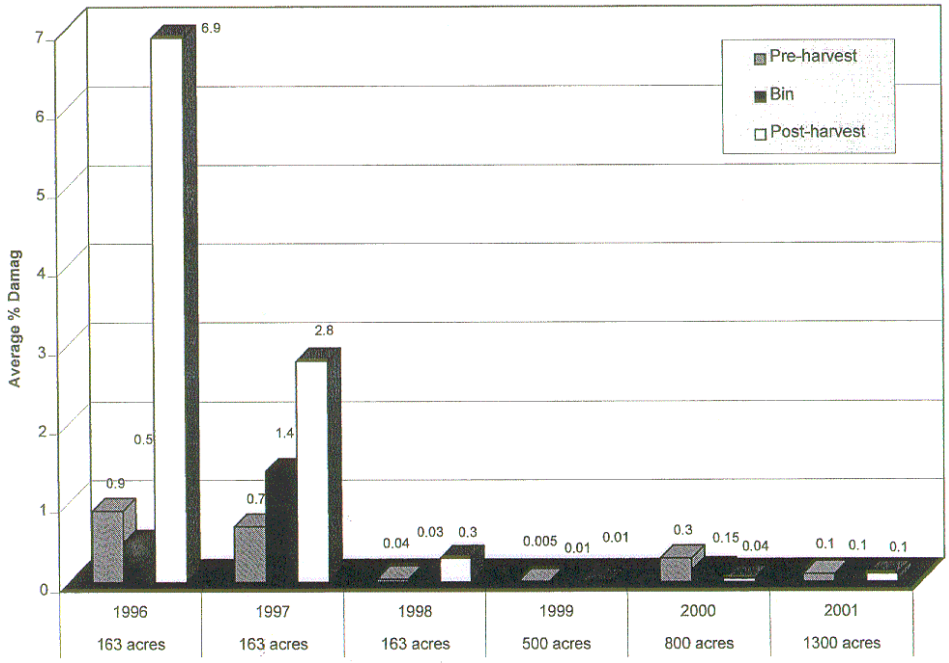
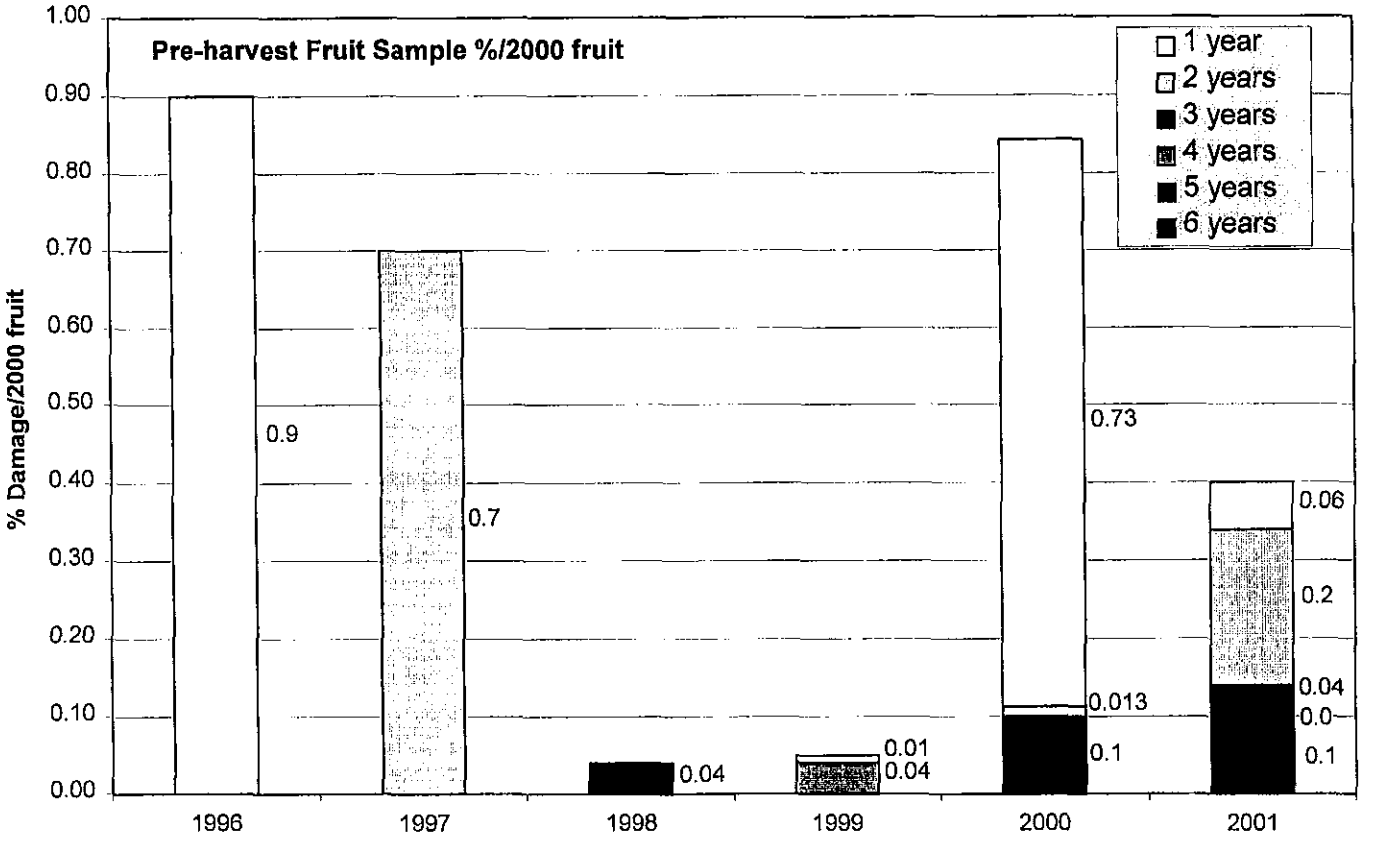



**Figure 2:** Effect of years in project on total average damage in all puffer-treated orchards, Kelseyville, Lake County, 1996 - 2001



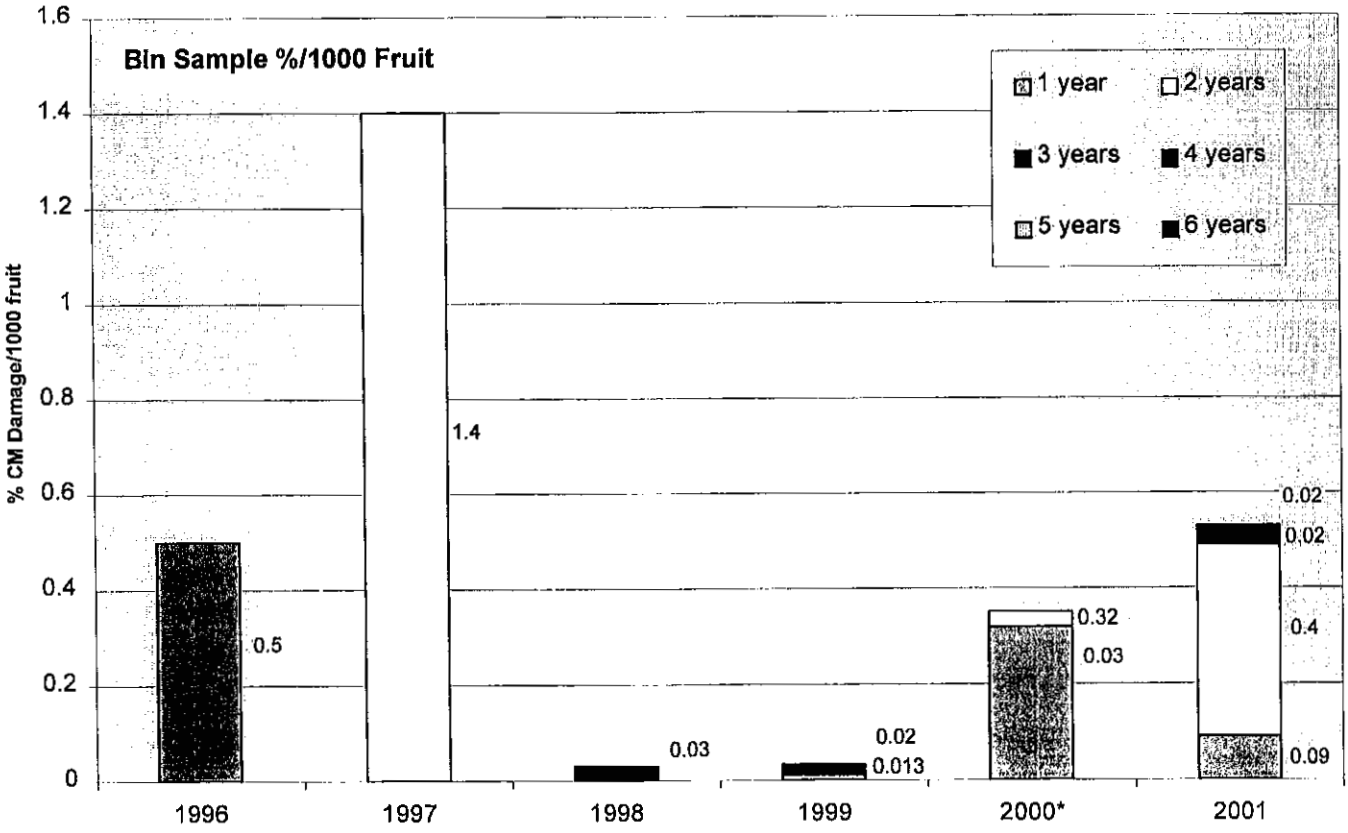

**1996, 1997, 1998:** 5 blocks

**1999:** 1st yr. – 16 blocks
4th yr. – 5 blocks

**2000:** 1st yr. – 16 blocks
2nd r. – 16 blocks
5th yr. – 5 blocks

**2001:** 1st yr. – 21 blocks
2nd & 3rd yr. – 15 & 14 blocks
4th & 6th yr. – 3 & 5 blocks

**Figure 3a:** Effect of time in puffer project on CM damage, Kelseyville, Lake County, 1996-2001




**1996, 1997, 1998:** 5 blocks

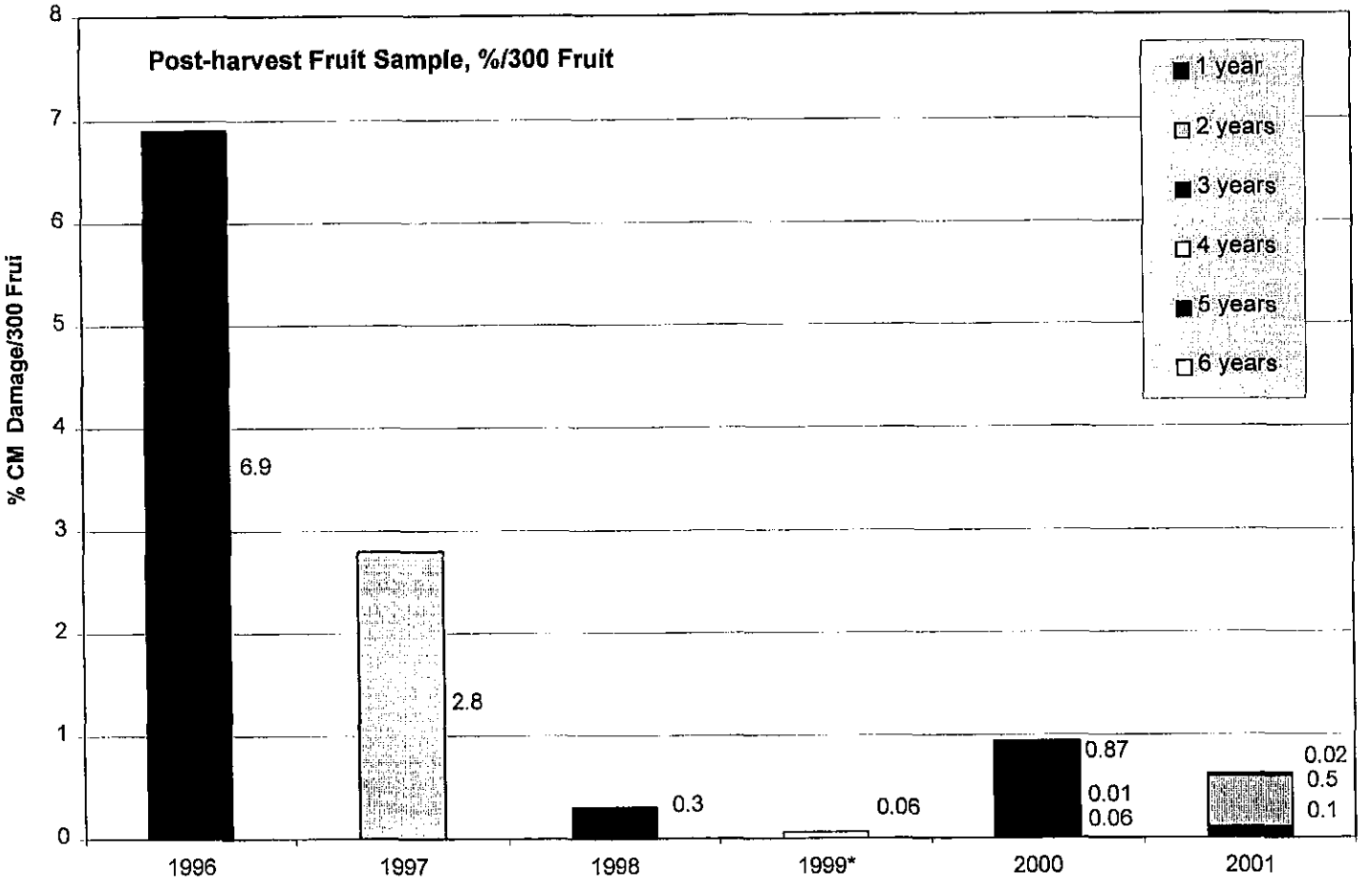
**1999:** 1st yr. – 16 blocks
4th yr. – 5 blocks

**2000:** 1st yr.- 16 blocks
2nd yr. – 16 blocks
5th yr. – 5 blocks

**2001:** 1st yr. – 21 blocks
2nd & 3rd yr. – 15 and 14 blocks
4th & 6th yr. – 3 & 5 blocks

* 2000: 5th year blocks had zero damage

**Figure 3b:** Effect of time in puffer project on damage at harvest, Kelseyville, Lake County, 1996 - 2001



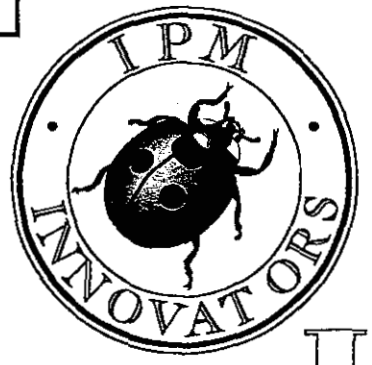

**1996, 1997, 1998:** 5 blocks

**1999:** 1st yr. – 16 blocks
4th yr. – 5 blocks

**2000:** 1st yr. – 16 blocks
2nd yr. – 16 blocks
5th yr. – 5 blocks

**2001:** 1st yr. – 21 blocks
2nd & 3rd yr. – 15 & 14 blocks
4th & 6th yr. – 3 & 5 blocks

Figure 3c: Effect of time in puffer project on damage at harvest, Kelseyville, Lake County 1996 - 2001




California Environmental Protection Agency

Department of Pesticide Regulation

# IPM Innovator

**Lake County Areawide Codling Moth "Puffer" Project**

is hereby recognized as an "IPM Innovator" for its leadership and creativity in advancing the use of reduced-risk programs for pest management in the pear industry.

Paul Helliker

Paul E. Helliker, Director

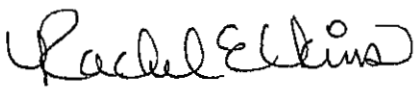
11/3/00

Date

# COOPERATIVE EXTENSION
# UNIVERSITY OF CALIFORNIA
## County of Lake

December 3, 2001

To: Lake County Board of Supervisors
Ed Robey, Chair
Rob Brown
Tony Farrington
Gary Lewis
Jeff Smith
Kelly Cox, Administrative Officer



From: Rachel Elkins
Farm Advisor

Re: Lake County Puffer Project

Attached is a recent article from the statewide newspaper Ag Alert, published by the California Farm Bureau Federation. I hope you enjoy reading about the continuing efforts of local pear growers to reduce organophosphate use. The puffer program received the 2000 Integrated Pest Management Innovator Award from California Department of Pesticide Regulation, one of the 8 out of 33 entries statewide to do so.

Please contact me if you would like more information about the program, or other research efforts of the local pear industry.

srm

enclosure

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U.S. Department of Agriculture, University of California and County of Lake Cooperating

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CALIFORNIA

# TREES & VINES®

A SPECIAL GROWERS SECTION OF AG ALERT®

Photo/Christine Souza

**Pheromone dispensers in pear orchards provide insect control through mating disruption.**

# Lake County pear puffer project is a hit with growers

**By Christine Souza**
**Assistant Editor**

Northern California pear growers are encouraged by results of this year's Lake County Puffer Project, a mating disruption program led by University of California Cooperative Extension to control codling moth and monitor oblique-banded leaf roller in pears.

"Puffers have done very well. We hardly spray in there; it's incredible," said pear grower Lars Crail of Kelseyville, who farms 170 acres of pears and 30 acres of winegrapes on a site that dates back several generations. "We haven't had to put on any organophosphates for the past several years. It is basically an organic program except for weed spray."

With the start of the Puffer Project in Lake County in 1996, five pear growers including Crail installed pheromone dispensers, or "puffers," in five pear orchards to reduce the amount of codling moth and a secondary pest, the oblique-banded leaf roller. Today, the number involved in the project has expanded to 16 growers and 56 orchards.

"The project is an area-wide pheromone-confusion program for codling moth using the widely-spaced dispenser at the application rate of one to two per acre," said Rachel Elkins, UCCE farm advisor for Lake and Mendocino counties, plus Sutter and Yuba counties for pears. "Traps are used to monitor what the codling moth population is doing and also whether the pheromone is confusing them sufficiently enough so that they cannot locate the traps. That's the whole purpose."

In the past, Lake County pear growers have experienced the most problems with two major pear pests, codling moth and oblique-banded leaf roller. UC researchers have found, of every pear pest, codling moth has the greatest potential for damage. They also have learned codling moth, which stings the fruit, can be effectively controlled with properly timed treatments.

Researchers say codling moth has gradually developed resistance to Guthion and other organophosphate insecticides, and cross resistance to other classes of insecticides. Codling moth populations now require more frequent applications of the insecticide and at higher rates. Researchers such as Elkins say mating disruption is most successful in flat orchards like those of Lake County, with relatively low codling moth populations.

In orchards with moderate-to-high populations and/or in the first year of mating disruption, insecticides or other supplemental controls may be needed in addition to the mating disruption program. Pheromone dispensers, such as those used in the Lake County Puffer Project, are placed in the upper third of the tree canopy before the first moth emergence in early March to early April. Puffers were placed on every 1.1 acres of the Lake County Puffer Project orchards in 2001. The pheromone, codlemone, is released every day at 3 p.m. and the canister continues to spray the treatment every 15 minutes until 3 a.m. Puffers are placed along the upwind edges of blocks every 50 to 65 feet and on downwind edges every 100 to 125 feet.

Elkins indicated the program is most successful when very few moths are found inside the traps. Codlemone is intended to confuse the moths and so they are unable to locate the traps.

Although the project is specifically intended to treat codling moth, data on the secondary pest, the oblique-banded leaf roller, are also monitored and recorded.

"We have a program we have developed for leaf rollers but it is not a pheromone program yet. We take leaf roller data in the puffer project because we feel it is important since they are a major secondary pest in pears," Elkins said.

See PUFFERS, Page 13

*UC farm advisor Rachel Elkins of Lake County encourages pear growers to utilize 'puffers' in their orchards.*

# Puffers

Continued from Page 9

The oblique-banded leaf roller feeds on the surface of the fruit. Elkins said this pest was initially controlled by Guthion, a product used to kill codling moth. Now that growers seldom spray organophosphates for codling moth, leaf roller populations have caused damage in a number of pear orchards. With codling moth, Elkins said the larger the number of trap catches, the greater the damage. This is not the case with oblique-banded leaf roller.

"We catch hundreds of them," Elkins said. "And with leaf rollers there is no correlation between damage and your trap catches. You can catch 2,000 leaf rollers in your traps and not see any damage."

Puffer Project data for 2001 show the number of trap catches and percentage of damage for both codling moth and oblique-banded leaf roller. With puffers hung in the first week of April, the total number of trap catches through July 11 for 31 pear plots totaled 4 moths, 35 moths and 67 moths for various types of codling moth traps. Catches for the oblique-banded leaf roller trap totaled 1,897 moths.

"We've only caught four codling moths in our low traps through July, whereas in just two of the control orchards we've caught 16 moths, so there are a lot more moths per orchard in the untreated than in our puffer orchard. So that is good. That aspect of monitoring is working," Elkins said.

Looking at damage caused in the orchards, the total percentage of damage caused by the first generation of codling moth totaled 0.05 percent and the untreated control reached 8.35 percent. Oblique-banded leaf roller damage totaled 0.09 percent and damage to the untreated control topped 0.4 percent.

"We look for fruit that has worm damage and that really is the bottom line. We look at it several times a year and these are the different counts," Elkins said.

Growers and pest control advisors involved in the program receive a faxed weekly report of project progress. Elkins informs participants on the number of catches, degree-day accumulation and egg and damage sampling results.

Due to the success of the program, growers agreed to expand the use of puffers to additional acres in 2002.

# Area-wide pest control program effective on apples and pears

By Bob Johnson
Special to Ag Alert

Two ongoing University of California research projects are demonstrating that both the effectiveness and economy of integrated pest management approaches to codling moth damage in stone fruit improve if the approach is adopted over a fairly wide area, and for a fairly long period of time.

One of these research projects is among apple growers in Contra Costa County and has an additional angle of trying to find a way to keep farming in the vicinity of a large urban population.

The other project is among pear growers in Lake and Mendocino counties who have been trialing the aerosol pheromone puffer that was first developed by UC but has since been taken up by Paramount Farming Co.

"The second year the cost went down," said Janet Caprile, UC Cooperative Extension farm advisor in Contra Costa County. Total pest control costs in the first year of the program that emphasized mating disruption pheromones was $440 an acre, compared to $270 an acre using conventional apple orchard pest control methods. But in the second year of a mating disruption program the pest control costs dropped to $347 an acre.

The cost comes down over time, in part, because of the reduction in the codling moth population. But a major benefit is that the reduction in using hard chemicals to control the codling moth reduces the cost of controlling secondary pests by increasing the population of beneficials.

"When we switch to mating disruption we don't need to spray for as many pests like leafhopper, leafminer and mites," Caprile said.

In order to gain the benefits of larger blocks, 19 Contra Costa farmers with a combined total of 640 acres of apple orchards have been enrolled in an area-wide IPM program that emphasizes mating disruption to control codling moth damage.

"The bigger block you can get, the more successful it's going to be. In areas like Watsonville or Contra Costa County you don't have a thousand acres of apples all in one place," said Caprile.

This area-wide approach decreases the cost per acre because entire farm neighborhoods are flooded with the pheromone that disrupts codling moth mating. It also further reduces costs by increasing the population of beneficial insects that control secondary pests as well as the codling moth.

"Mating disruption is a good program but it doesn't work in all situations," Caprile said. She noted in particular that there can be control or economic programs in orchards that are too small, the wrong shape or subject to mated moths coming in from the outside.

But Contra Cost County apple growers in the program have reduced their use of organophosphates and carbamates by between 60 percent and 90 percent, Caprile said. And codling moth damage was just 1 percent in the first year of the program.

"Nineteen orchards, totaling 656 acres, were enrolled in the apple project in 2000, the first year of this project. The Biologically Integrated Farming Systems orchards, by using pheromone mating disruption, were able to reduce the use of organophosphates by 59 percent and carbamates by 92 percent in their first year," reported the UC Sustainable Agriculture Research and Education Program. "The use of all traditional pesticides was reduced in the BIFS orchards by 72 percent. The amount of reduced risk materials (pounds of active ingredient per acre) comprised 93 percent of all pest management materials used. Since the apple BIFS project has provided a cost share for codling moth control materials, the actual grower cost is $296 per acre, which is only $10 more than the conventional cost."

The real test, however, will be whether mating disruption will be seen by the growers as an economically viable alternative after matching funds from UC and the state Department of Pesticide Regulation are no longer available. Caprile suggested, "They will if we've been able to successfully bring down the codling moth population."

The importance of an introductory period, during which the costs of the IPM techniques come down and growers become more comfortable with the approach, has been dramatically demonstrated by the very different reactions of two groups of Northern California pear growers.

Pear growers in the Potter Valley of Mendocino County tried pheromone mating disruption in 1999 with Paramount Farming supplying the aerosol puffers free of charge. Codling moth damage was a miniscule 0.34 percent in the conventional orchards and 5.3 percent in the organic orchards, according to UCCE farm advisor Rachel Elkins. And all the growers were able to cut back to just one early season organophosphate application.

The popularity of the pheromone puffer program continues to grow among pear growers in Lake County, where it was first introduced in 1996.

Codling moth control was achieved mainly through the use of pheromones in at least 2,500 acres of pear orchards in Lake County this year, Elkins said, and the program figures to expand next year.

As the codling moth population has been reduced and the beneficials population has increased, most of the growers have cut back on their use of organophosphates by 80 percent to 90 percent.

And growers who have been using the puffers for years are now able to get by with barely more than one puffer per acre. This brings a substantial labor savings over hanging hundreds of pheromone ties per acre twice each season.

"I started in 1996 with 160 acres and I have not had one grower pull out of the program. The puffers work effectively when they are used over a wide area," said Elkins.

Ag Alert
January 16, 2002
pg. 11

AES/CE MAR 84 Workgroup/Department: _____

University of California
Division of Agricultural Sciences

**PROJECT PLAN/RESEARCH GRANT PROPOSAL**

Project Year: **2002-03** Anticipated Duration of Project: **1 year**

Project Leader: **Rachel Elkins** Location: **Lake County**

Cooperating Personnel: **Frank Zalom, Carolyn Shaffer**

Project Title: **Correlation of trap catch and damage data to provide information for use in developing efficient use of monitoring time in mating disruption orchards; the Lake County "puffer" project as an example**

Keywords: **mating disruption, codling moth, monitoring**

Commodity(s): **European pear** Relevant AES/CE Project No. _____

**Problem and its Significance**

A great deal of time and expense is spent on pheromone trapping in mating disruption programs. Trap monitoring is the primary tool used commercially by PCA's and/or growers to systematically determine whether or not to treat. Damage and egg sampling are also used, but less systematically and consistently because of the labor requirements of these methods. The number of traps thought to be needed is much higher on a per orchard basis for mating disruption than for standard program blocks. Users must decide on various combinations and densities of 1X low, 1X high and 10X high traps, which can be very confusing. In addition, there are many types of lures and trap bodies available.

While it is acknowledged that many factors preclude establishing set thresholds using pheromone traps (i.e. if "X" moths are caught, then spray), it must also be recognized that pest control personnel have only a finite amount of time to spend in each orchard, and growers have only a finite level of resources to pay for monitoring. Our data set represents extensive observations of trap catch and damage. While the demonstration project was not designed or intended to develop damage relationships, it seems worthwhile to extract as much information as possible from these data.

The Lake County puffer program from 1996 – 2000 featured:

- uniform trap deployment (location, type/brand/lure monitoring);
- systematic damage sampling through the season and post-harvest; and
- well documented treatment records.

About 50 hours was spent in 2001 learning to set up the data and run correlations between various combinations of trap types and catches and different damage timings, with encouraging success (Table 1). However, certain key orchards failed to fit the model. It was decided that confounding factors such as CM treatments and trap density must be factored in. It is thus proposed to do a more complete analysis of available data incorporating these variables. We hope that this will provide pest management decision-

makers information that can be used to plan how valuable time should be spent in the orchard, e.g. increase or reduce trapping effort at certain times during the season versus increase or reduce egg or damage sampling.

The information from this preliminary study will be utilized in a larger study to be proposed to non-industry funders later in 2002 by the P.I. and Dr. Frank Zalom. If funded, the puffer program will be used as a model for a study utilizing geostatistics to analyze relationships between dependent variables (trap catch and damage data) and various independent factors (wind direction, distance from borders, unfarmed trees, etc.) (attached article).

**Table 1: Preliminary Correlations – 1996-1999** (all orchards regardless of treatment)

| Trap type and timing | Damage sample | $r^2$ value | P-value |
|---|---|---|---|
| 10X high, 1st flight | pre-harvest tree | 0.91 | * |
| 1X high, total | bin | 0.87 | ** |
| 1X high, 2nd flight | bin | 0.81 | ** |
| 10X high, total | bin | 0.97 | *** |
| 10X high, 1st flight | bin | 0.95 | *** |
| 1X high, total | post-harvest tree | 0.96 | *** |
| 1X high, 2nd flight | post-harvest tree | 0.93 | *** |
| 10X high, total | post-harvest tree | 0.95 | *** |
| 10X high, 1st flight | post-harvest tree | 0.93 | *** |
| 10X high, 2nd flight | post-harvest tree | 0.98 | *** |

**Objectives**

Seasonal trap data from orchards meeting specific criteria (CM treatment, trap density, etc.) will be statistically correlated with damage levels measured at various times through the season. The best "fits" will be determined ($r^2$ value). Results will be used to provide suggested monitoring guidelines for future use, and will be validated using data from the 2001, 2002 and possibly 2003 seasons.

***Plans and Procedures***

1) Divide the orchards into categories:

   - no OP, 1 OP, >1 OP
   - <4 traps, ≥ 4 traps
   - with or without open borders
   - upwind (northwest, west, south) vs. downwind/mid (east)
   - others as appropriate

2) Perform statistical correlations using the following data in various combinations:

   - 1XL, 1XH, 10XH CM trap catches:
     overwintering (1A, 1B), 2A, 2B, 3rd flights, total seasonal catches for each trap type
   - 1st generation (tree, ground), 2nd generation (tree, bin), 3rd generation (bin, post-harvest tree) damage

3) Validate the best trap/damage combinations and scenarios during the 2002 season; document problems.

4) Provide information to PCA's so they can validate them as well and suggest needed changes and additions.

**Budget**

| | |
|---|---|
| Salaries and benefits | |
| Laboratory Assistant II | |
| 2 months FTE @ $11.91/hour | $ 4,145 |
| Benefits | 415 |
| **Total** | **$ 4,560** |

_____ Date _____
Originator's signature

COOPERATIVE EXTENSION

County Director _____ Date _____

Program Director _____ Date _____

AGRICULTURAL EXPERIMENT STATION

Department Chair _____ Date _____

Liaison Officer _____ Date _____

D2454-2 (1/84)
(Rev. 9/96)